THE THEORY AND PRACTICE OF PRICE STATISTICS.

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There has often been noted in the development of statistical science a wide divergence between the theoretical, professorial treatment of the subject and the views of practical statisticians. This divergence has been frequently a direct conflict of opinion. At other times it has seemed rather that the connection between the work of the theorist and the practical man has been wanting. The latter has drawn no principles of action from the doctrines of theoretical writers, and he has been loath to believe that the cause of statistics has been strengthened by them. He knows full well that the general public for whom his labors are primarily intended has no knowledge of these speculations nor interest in them. In consequence of this fact theory and practice have developed side by side, and any reflex action which one may have exerted upon the other has proceeded almost exclusively from practice, and very little from theory. The explanation of this fact may be due to the circumstance that what has frequently been called theory is not in any sense distinct from practice, but merely a refinement of the precepts of experience. If, however, there is any distinct theory of statistics, it should accord not only with the practice of working statisticians, but should indicate clearly and distinctly the general lines along which all successful statistical effort should be conducted. In his *History, Theory and Technique of Statistics*,* Prof. Meitzen believes that he has made a general statement of statistical theory applicable to all forms of statistical investigation. Since Prof. Meitzen is of the opinion

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that the essence of statistical science is its method, it will readily be seen that such a general statement is not beyond the range of possibility.

The treatise of Prof. Meitzen is of rather an abstract character, and illustrations do not figure prominently upon his pages. It seems to have been his effort to state his general views in the most condensed form, and to leave the application of them to the reader. It is the object of the present discussion to consider the subject of price statistics in the light of Prof. Meitzen's theory. The effort will be made to show how according to the theory price statistics would be collected, and how the practice accords or disagrees with theoretical percepts. We shall then examine whether the rules drawn from the theoretical consideration of statistical methods will be of service in the use of price statistics.

Statistics is the investigation of aggregates by the enumeration of their component elements, and the comparison of the results. These two steps are clearly marked out. Through the enumeration of the elements we arrive at a knowledge of the aggregate in question. We ascertain that it contains a certain number of units of a given description. The larger the number of units enumerated in the same aggregate the more accurate is our knowledge of it. The groundwork of all statistical effort is such enumeration, and the theoretical rules which apply to unit and aggregate, which must be observed to maintain the integrity of the result, are of universal validity. But the knowledge of the aggregate is unrelated, and obtains its real significance when we compare it with other aggregates of the same general character. This second step of comparison is of no less importance than the first, and intimately related to it.

In every statistical inquiry there are these two steps,—enumeration and comparison, in some cases clearly defined, in others less obvious. We shall consider in turn with especial reference to prices the principles of enumeration and those of comparison. The principles of enumeration above outlined

are sufficiently familiar in their application. In statistics of population we discover sex, age, education, and a host of other characteristics in their numerical distribution in a given population. By increasing the number of characteristics we increase our knowledge of the object of our investigation, the population of a given region. It is clear that when our enumeration is complete our result stands in the form x males and y females in a population, which is typical of all the results.

While nothing could be clearer than the applicability of these principles to population statistics, it cannot be denied that when other branches of statistical inquiry are considered the force of these propositions is not so obvious. In the whole field of economic statistics their significance is not apparent at first glance. In population statistics the elements of aggregate and unit are sharply outlined. Not so in economic statistics. So distinct seem the problems of these two fields of inquiry that it does not appear probable that one could be of benefit to the other. It is not surprising that, historically, they developed independently. If, however, there is any unity in statistical inquiry, what is true of one field of research must apply equally well to the other. If any general formulation of statistical theory is to be considered valid, it must be quite as fruitful in the one field as in the other. Our present concern is to discover if possible in price statistics the analogy with the processes of enumeration here discussed. In the statistics of prices the form of statement is quite different from that customary in the statistics of population, and it would appear that the elements of aggregate and unit were not present. These statistics deal largely in averages, while in population statistics the average is little used.

To suppose price statistics collected in the same way as population statistics, we may consider the aggregate as the total sales of a given class in a given area and period of time. In this case the unit of enumeration would be a certain quantity of the thing sold. The problem would be to discover the exact quantities, in other words, how many units

were sold at each price which may have occurred during the period. The result would be a statement that, of all the goods sold, such a quantity or proportion was sold at the price x, so many at y, etc. Such a form of price statistics might under certain circumstances be very useful. According to statistical theory it is the normal form, and hence incidentally the test of the forms in common use.

The normal form of price statistics is not found in practice. In all branches of economic statistics its use is rare. Yet it needs but little consideration to convince us that it is the normal form. A striking analogy is furnished in the statistics of wages. It has been common to state wages as average wages, but the serious drawbacks to such a statement have led to the more explicit form of classified wages.* This classified wage statement approaches very closely the normal form, which is the first result of statistical enumeration. A further illustration of the use of the normal form in economic statistics may be seen in the statement of the rates of interest on mortgages brought out in the investigation which is being conducted by the Eleventh Census.† The writer has used the classified form in treating of the capital of corporations.‡ Instances need not be multiplied to show that what statistical theory would call the normal form is quite as applicable to certain economic statistics as to those of population.

Statistical theory requires its application to the statistics of prices, but the great difficulty of the case and the comparative value of results obtained by more summary processes have led to the substitution of the latter in many instances for the exact enumeration. In dealing with prices, the aim of the investigation is to obtain as concise a statement as possible of price at a given time and at a given place. This takes the form of the average. From any detailed statistical statement, as for instance the wages of workingmen, or the

* See Evolution of Wage Statistics by Carroll D. Wright, *Quarterly Journal of Economics*, Vol. VI, p. 151 (January, 1892).

†See A Plea for the Average, George K. Holmes, Vol. II of these Publications, p. 421.

‡ Statistics of Private Corporations, Vol. II of these Publications, p. 50.

ages of the population, we can form an average. Such an average is not theoretically distinct from an average price, but the latter may be of great value and the former comparatively worthless. In other words, the end and aim of all statistical work is to find a concise expression for a group of facts. The facts may be so constituted that the most valuable statement is an average, or they may be such that another form of statement is more expressive.*

In the illustration noted above, the age of the population, the deviation on either side of the average is so, great the possible groupings of the facts so numerous, that the average does not give us any very definite information. In a less degree the same applies to wages, and while, therefore, the average may suit certain purposes it does not satisfy the entire range of statistical problems touching wages. As a rule, the reverse is the case in the statistics of prices. Here the general tendency is vastly more important than the deviations from it which in the main are insignificant. The forces which work towards uniformity of price are so much stronger than those which act in the opposite direction that little time need as a rule be spent in the study of the latter. Hence, the aim of price statistics is the average price.

The average age of the population derived from the individual ages of all the members must be a true average. If price statistics should be collected in such a way that we knew the exact quantities sold at each price, we could obtain a true average price. But this is in the rarest cases possible. It is claimed that the price reports of some commercial bodies are constructed on this plan. Where the commerce in any commodity centres in an exchange of any character, it is evident that such process involves but little difficulty. Where this is not the case the difficulty of obtaining exact reports on the amount of sales is so great that it is not attempted.

* Statistical nomenclature is somewhat at sea on the subject of the average. In this paper average means, with Venn, a single artificial value, substituted for a group of actual, concrete values. His use of the term "mean" for arithmetical average seems confusing, and in this paper that idea is expressed by true average. See Venn, On the Nature and Uses of Averages, *Journal of the Royal Statistical Society*, Vol. LIV, Sept., 1891, p. 429.

Theoretical statistics requires the true average. But the true average rests upon an actual enumeration which is almost if not quite impossible. We now enter the field of statistical practice, and here we find various methods of ascertaining average price, which, in theoretical language are substitutes for enumeration. It becomes our duty to subject these substitutes to the test of theory. This discussion dees not purpose to be exhaustive, but to include the more prominent substitutes. The substitutes for the true average which claim our attention are what may be termed the "average of experience," the average of rates, the mean between highest and lowest price, and the representative price.

What I have termed the average of experience is the opinion of persons supposed to be perfectly familiar with the conditions of commerce of the article whose price is quoted. Upon such expert opinion we are forced to rely very largely in the price quotations of trade journals, which form the bulk of recorded prices. Such journals frequently publish prices as highest and lowest, but a single average quotation is not infrequent. How the figure is obtained can, as a rule, only be surmised. It seems probable, however, that the process of obtaining a true average is followed if only in a crude way. The expert knows that large sales have been made at various prices. He will select the price at which sales have been largest, and then consider whether the sales made at other prices have been of importance enough to warrant a deduction from or increase of the most frequent price in making his quotation. In so doing he rounds off his results for convenience sake. The true price average would in many cases be an indefinite number of decimals, but practical considerations hold the expert to certain familiar fractions of cents, or in articles of considerable value of dollars. Quotations of this character, while they do not lay claim to absolute accuracy, still attain in many cases a high degree of precision. They have the confidence of the commercial world, and wide-reaching business enterprises are founded upon them. Scien-

tific statisticians may be disinclined to use figures the accuracy of which cannot be tested, since their origin cannot be traced. But any statistics not founded on actual enumeration are impossible unless confidence be placed in the judgment of those who furnish the original data.

The average of rates is a simple expedient of finding the actual different prices at which the goods in question have been sold, and taking their average irrespective of the quantities sold at each particular rate. Such a process is clear and open, but a question may be raised as to its value. It proceeds on the assumption that the amount of goods sold at each rate is substantially the same. Such an assumption may or may not hit the facts very squarely, but it underlies, as will be seen later, a very considerable part of the work done in the statistics of prices. If the range of variation be not great an average of rates will approach quite closely a true average, and under normal conditions of trade this will be the case.

The mean between highest and lowest price is frequently employed as an average price. It is, perhaps, the least satisfactory of all. If no unusual factors determine the extremes, it is evident that a point midway between the two extremes must come very close to the true average if we can assume a fairly equal distribution of sales at the various intervening rates. As compared with the average of rates this method is inferior, since, besides the assumption of equal distribution of sales which both have in common, this method suffers from the difficulty of an accurate determination of the extremes. While in a concentrated market the difficulty is less, in a diffused commerce it is quite considerable. There are sales which take place under unusual circumstances which are very apt to affect the extremes of price. The question whether these are to be considered commercial sales, and, therefore, the extremes of price, is one that the collector of information must decide, and reliance must be had in his judgment. It should be noted that in the average of rates the inclusion of

these extreme prices will affect the result, though not in so marked a degree as when the result depends upon the extremes only.*

In the three substitutes for the true average thus far considered we deal with an artificial construction in many respects less satisfactory than the true average. But there are some who object to any average, who desire actual concrete facts. It must, however, be evident that we cannot express a group of facts in a single expression which shall be typical of the whole unless it be an average or approach the average in its nature. If we compare a composite photograph which has some analogies to a statistical average with the photographs of the persons who compose it, we will surely find a head which differs less than the others from the type revealed by the composite picture. This head may then be taken as a representative of the type. If there were any means by which this representative could be found without the tedious process here indicated, it would be a great gain. Something parallel to this is done in those statistics of prices which place the representative price in lieu of the average. The laws of trade are so well known that if, instead of pursuing any of the courses here marked, we choose a place where the normal conditions of competition are present, and a normal trade carried on, the specific price in that place or that establishment must approach very closely the average. In this method we secure a result that is purely concrete. It is taken from actual sales. It can be used for statistical purposes because it typifies the true average, and is probably as near an approach to it as can be secured, provided always that insight and judgment have been used in the selection of the establishment. Here again reliance must be placed upon the good faith and the ability of those who collect the figures.

Each of the four substitutes for the true average has its

*An illustration of this form of price statistics is found in the statistics published each year as an appendix to the *Zeitschrift des konigl. preuss. Statistischen Bureau.* They give the prices of certain commodities in 165 markets in Prussia, arranged as highest, lowest, and mean price.

justification. Each abbreviates the statistical method of enumeration. Each requires us to have confidence in the ability and fidelity of those charged with the work. There are practically no price statistics collected by the normal statistical method. It would be an impossibility except in rare cases and restricted areas. In all price statistics we are, therefore, dealing with what Meitzen calls estimates.

The substitutes which we have discussed have their justification in their approach to the average. They can, therefore, be used only when the purpose of the investigation is to ascertain an average price. As has been said, this is the usual aim of inquiries into the statistics of prices, but there are some cases in which the point of interest in prices is not the general tendency, but the deviation from it. The substitutes noted are chiefly of value in the discussion of wholesale prices. They fail utterly when retail prices are to be considered. In retail prices there is a wide variation, and the interest attaches to its extent. This has been the burden of several recent investigations into the course of retail prices. Any method which obliterates the distinctions between them must be faulty. Again, the prices paid in primary markets to the producers of agricultural products vary widely, not only from the market prices of such commodities in the principal distributing centres, but also from each other. In other words, the causes which affect the two classes of prices which we have named are totally distinct from those which govern market prices. An investigation of them must therefore proceed along other lines. No other plan meets the requirements of the case so fully as that of selecting representative establishments or representative primary markets and obtaining the prices in them. But, on the other hand, great care must be exercised in the formation of averages from such data, and it will be observed that the representative establishment plays a very different role in the statistics of prices from the "representative price" which has been discussed.

In the foregoing discussion, both of the true average and

of its various substitutes, no mention has been made of the limits of the inquiry either in time or locality. The discussion is applicable irrespective of these limits, but since it is evident that a price for the whole world, or for a whole century, would be comparatively worthless, attention must be given to these limits.

Let us suppose that the prices had been obtained by any of the methods above described in a given locality. It is evident that in order to cover a larger territory, as a state of a nation, the same methods must be used, theoretically speaking, as in a more restricted district. But to obtain wholesale prices in every locality where the goods were sold, and the volume of the sales, would be a manifest impossibility. We must assume that the prices in these localities are governed by the usual laws of trade, and that the course of prices of those places where the largest volume of sales occurs sufficiently represents the trend of prices for the nation. If a large number of places are selected, and all used in the formation of an average of rates, an equal importance is given to each place, and this may impair the result unless they are approximately equal. Thus in the Prussian figures a very considerable number of small towns in the neighborhood of Berlin are included. In taking an average of rates they may, if all should be higher or lower than Berlin, outweigh the latter in the result. In this respect the figures presented by the Imperial Statistical Office are superior, since they include only the most prominent markets.* In obtaining the wholesale prices, therefore, practical necessity, justified as we have seen by theoretical considerations, compels the statistician to confine his attention to the principal markets. On the other hand, if we consider the two classes of prices already noted as exceptions from the general rule, retail prices and prices paid to farmers, it is evident that to gain an idea of them from a considerable area that a larger number of points must be selected than in wholesale prices. The conditions govern-

*See for illustration *Monats hefte zur Statistik des deutschen Reiches*, Dezember, 1890.

ing retail prices differ in a village from those of a manufacturing town or a large city. The different classes of communities which are represented in the district in question should all be represented in the statistics of retail prices, and of prices paid to farmers. An admirable illustration of the application of these principles is to be found in the investigation of prices both wholesale and retail which is now being carried on by the Senate Committee on Finance. While for wholesale prices the main distributing points in the United States have been selected, for retail prices as many as seventy different points have been chosen, and for prices paid to farmers a still larger number. The details of this work will not be before the public for some months, but the plan has already been described by Mr. Carroll D. Wright in the *North American Review* for December, 1891.

Prices are quoted as daily, monthly, and yearly prices. The latter two may be derived from the former, or may be gathered independently according to any of the methods which have been described. Much depends upon the character of the commodity and of its sale. Staple articles are quoted daily, or else weekly. In ascertaining from the daily or weekly prices the monthly or yearly prices the usual rule is to simply take the average of the prices quoted without regard to the quantities which may have been sold on each day or week.* Such a process is only another application of the average of rates already discussed, and proceeds on the assumption that the volume of sales does not essentially differ from day to day, or from week to week. The difficulties which would surround the effort to estimate the volume of sales have already been alluded to, and prevent obtaining a true average. An exception to this rule is sometimes found in the statistics of prices of manufactured commodities, where

*This method is very generally applied in the trade journals, as in the *Bulletin of the American Iron and Steel Association*, and many others too numerous to mention. It is also applied in the statistics of the German Imperial Office already mentioned. The late Professor Beaujon (*Bulletin de l'Institut International de Statistique*, II, 145) speaks of average monthly prices as the basis of price statistics, and the derivation of average yearly prices from them.

the set price is obtained by dividing the total sales for a given period by the total product. This gives a true average price. but it is valueless for practical purposes unless the product consists of a single article, and is not made in dfferent styles or qualities. These conditions are rarely realized in trade. Another form of price statistics, not unlike those just mentioned, are the average import and export prices of commodities. Statisticians are familiar with those published by the English Board of Trade, the French "Commission permanente des Douanes," and our own Treasury Department. There can be no doubt of such prices being true averages. But the prices so calculated will find a low level if the bulk of the goods are of inferior quality, and a high level if they are of superior grade. One can never know just what such a price represents, since the mixture of high and low grade goods may be infinitely varied. Though they have been frequently used, such statistics of prices seem the poorest that exist, and only of value in default of better. In this discussion of the extension of price statistics in time reference has been had to those articles which figure in the accounts of trade journals, and in like publications. It is unnecessary to dwell upon the fact that in an original investigation yearly prices may be obtained by some other methods. Taking into consideration the general laws of trade, it will be observed that whatever method is pursued, the possibility of variation is only as great as the difference between the highest and lowest prices paid in the year. In order to illustrate the effects of different methods in the calculation of yearly averages, we give a table which presents some calculations on the subject. In separate columns we present the actual prices paid during the year for a certain article, an average obtained by dividing the total of the prices by the number quoted, the mean between the highest and lowest prices, the average of the daily prices, and finally an average of the prices ruling at the beginning of each quarter. An examination of the table confirms what has already been said. When

the range of variation is wide the different methods pursued do not approximate so closely as when the range is small. In the latter case substantial agreement is observed.

TABLE I. COMPARISON OF AVERAGES.

	Price.	Duration of Price.	Average of Daily Prices.	Mean of Highest and Lowest.	Average of Rates.	Average of Prices at Opening of each Quarter.
	Cents.	*Days.*				
1857	137½	56	.....	.....	.....	.....
	140	93	134.246	137.5	137.500	136.975
	135	216	.....	.....	.....	.....
1858	120	365	120.000	120.0	120.000	120.000
1859	127½	90	.....	.....	.....	.....
	130	275	129.384	128.75	128.750	129.375
1860	130	79	.....	.....	.....	.....
	125	95	120.177	125.0	125.000	123.750
	120	182	.....	.....	.. ....	.....
1861	120	67	.....	.....	.....	.....
	125	235	124.945	125.0	125.000	123.750
	130	63	.....	.....	.....	.....
1862	130	178	... ...	.....	.....	.....
	135	24	.....	.....	.....	.....
	140	40	.....	.....	.....	.....
	145	28	145.096	157.5	151.562	137.500
	150	18	.....	.....	.....	.....
	160	31	.....	.....	.....	.....
	167½	14	.....	.....	.....	.....
	185	32	.....	.....	.....	.....
1863	185	30	.....	.....	.....	.....
	200	25	.....	.....	.....	.....
	215	52	.....	.....	.....	.....
	200	115	200.452	200.0	197.500	195.000
	190	63	.....	.....	.....	.....
	200	49	.....	.....	.....	.....
	215	31	.....	.....	.....	.....
1864	215	49	.....	.....	.....	.....
	220	39	.....	.....	.....	.....
	225	17	.....	.....	.....	.....
	235	11	290.274	282.5	257.500	283.750
	250	36	.....	.....	.....	.....
	275	25	.....	.....	.....	.....
	300	12	.....	.....	.....	.....
	350	177	.....	.....	.....	.....
1865	350	88	.....	.....	.....	.....
	250	126	.....	.....	.....	.....
	265	54	.....	.....	.....	.....
	275	97	283.246	300.0	285.000	283.750
1866	275	92	.....	.....	.....	.....
	260	130	266.644	267.5	270.000	267.250
	275	143	.....	.....	.....	.....

We have shown that enumeration in the strict sense required by the theory of statistics is not practicable when prices are the subject of investigation. Resort must be had to various substitutes of greater or less accuracy according to circumstances. The character of these substitutes and some account of their application has been given, and we may now proceed to the second step in statistical inquiry, — comparison.

The comparison of the results of the enumeration is the final step in statistical processes. In the statistics of prices it seems to be the one feature of interest, but we have already demonstrated that an intelligent comparison is not possible without a careful criticism of the character of the information. The most important comparisons in price statistics are those between different localities, different periods of time, and different groups of prices, and they will claim our attention in this order.

The rules of statistical comparisons drawn from the theoretical consideration of the method are very numerous, though they may, perhaps, be summarized in the statement that no comparison is possible unless the analogy of the aggregates is sufficient, and the identity of the units is preserved. To this we should add a third rule in cases where an enumeration has not taken place, and it is that a similarity of the substitutes is necessary. The application of these principles to the usual statistics of population is so obvious that it need not be dwelt upon. It is our purpose to examine how far they throw light upon the comparisons of prices.

Let us consider, first, comparisons between the different localities. With respect to the analogy of the aggregates, it need only be said that this requires the self-evident rule not to compare one class of prices with another. Great care must be taken in making comparisons between localities to preserve intact the identity of the units. This is a matter oftentimes of the utmost difficulty. There are few products of commerce which are exactly the same the world over.

While, in a measure, this is true of certain agricultural products and raw materials of certain manufactures, when manufactured goods are considered, the greatest possible diversity is to be noted. The local comparisons of the prices of such staple articles as grain suffers frequently from a lack of uniform classification in the market quotations of the different commercial bodies.* Comparisons may be made between the prices of pig-iron in England and in the United States, and yet the manufacturer is well aware that a difference exists between the two kinds of pig-iron. Even rudest kinds of manufactured products differ not only from country to country, but from section to section. There is, for instance, no inconsiderable difficulty in comparing the price of cotton goods between Manchester and Fall River. When a higher class of manufactured goods is taken into consideration comparison is almost impossible. The utmost efforts are unavailing to secure any adequate basis for a comparison of the prices of silks as well as any other article which appeals to the fancy and artistic taste of the consumer. This wide diversity in the character of the products must lead to great caution in comparing the prices of articles in different localities even though the commodities be described as the same goods.

The force of what has been said in the preceding paragraph is much greater if we apply it to retail prices. The wide difference in prices which has been noted between articles of the same name, not only in different towns, but in different stores in the same town, forces us to the belief that the articles in question differ from one another in quality.† The taste of persons in different places varies, and this leads to differences in the quality of the goods sold. If this be true

*See the different nomenclature in the Statistics of the German Imperial Office, before noted.

†See on this point, Bayerdörffer, *Einfluss des Detail Handels auf die Preise, Schriften des Vereins für Sozial politik*, Vol. 37, 1888, p. 33. Also Cook, *Study of Retail Prices in Boston and Vicinity*, Vol. II of these Publications, p. 116. Similar experiences in the investigation of retail prices in France are noted by de Foville, *Bulletin du comité des travaux historiques et scientifiques*, Section des sciences economique et sociales, Paris, 1888.

of groceries and household goods in every-day use, it is still more the case in regard to dry goods and other manufactured products. I have in mind an instance from the current investigation of the Senate Committee on Finance, where in the same store two articles corresponding to the description suggested by the committee were quoted at the prices of respectively 13 cents and 60 cents a yard. Experience proves that, however carefully the questions may be framed, it is utterly impossible to describe many articles in such a way that retail dealers throughout the entire country will understand exactly what is meant. In many cases the only adequate description of a manufactured article is too technical for the average merchant not versed in the process of manufacture to comprehend.

In comparing the prices of different localities care must be taken that the prices compared have been obtained according to the same method. Our discussion of substitutes showed that various methods might be employed to give an approximate idea of price, but it must not escape our attention that while the tendency of one method may be to give a result slightly higher than the true average, the tendency of another method may be exactly the reverse, hence the comparison of prices can only be absolutely satisfactory when the methods pursued in the different localities are identical. Cases might arise in which it was desirable to compare the relation of wholesale prices at different points, and ascertain whether the same relation held true in retail prices. In such a case a certain town could be taken as a basis, and the relation of wholesale prices in other towns be calculated. In similar fashion the retail prices could be calculated. The two series would be comparable irrespective of the fact that the wholesale prices might have been collected by one method and the retail by another.

The comparisons between prices at different times are much more numerous and much more fruitful of results than those between different localities. What has been said above with

reference to comparing prices of the same groups applies with equal force here.

The articles whose prices may be compared are subject to change, and it may occur that between the beginning and the end of the period the commodity has so changed its quality that it is not identical throughout.* This, of course, impairs the value of the comparison, but does not render it absolutely worthless, since allowance can be made for such changes in quality oftentimes with little difficulty. This applies to slight changes only. Where the change is great it may make a comparison utterly worthless. Staple articles, especially the raw products of agriculture, are less subject to change than manufactured products. Such improvements in the processes of agriculture as have taken place in recent years affect much more frequently the amount of the product and the economic working of the farms than the quality of the crops. None the less such changes do take place, and in comparing, for instance, the prices of sugar beets at the time when beet sugar was first produced with the price for such product today, an allowance should be made for the greater value of the latter through the increase in the sugar content which the improvement in agricultural methods has gradually brought out. Such instances are, however, rare, and in comparing the prices of this class of commodity we can be certain of a great degree of accuracy.

On the other hand, manufactured products have changed so frequently during the last century through the entirely changed conditions of manufacture that a comparison of prices at different periods seems well nigh impossible. So far as I know no attempt has been made to calculate such prices on a large scale in European countries, and, indeed, Haushofer† roundly declares that it cannot be done. This being the case, it may be well to notice in some detail the methods which have been employed by the Senate Committee

*Compare *Labor Statistics*, Connecticut, 1888, p. 88.

†Compare the recent edition of his *Lehr und Handbuch der Statistik*, chapter on prices.

on Finance in its current investigation. The greatest possible care has been exercised to obtain prices upon exactly the same commodity during a long period of years. The number of different articles in every branch of manufacture is so great, and the changes in quality have been so frequent, that it would be utterly impossible to collect prices of manufactured goods by including all products. On the other hand, in nearly every line of manufacture there is some special article which has remained substantially the same for a long period of years. Through conference with representatives of various manufacturers these articles have been ascertained. They have then been used as representatives of the group of manufactures to which they belong. Care has been exercised that the articles selected should be competitive articles, goods for which there has been in the past a considerable sale, and whose prices have been governed by market conditions. In the course of this investigation certain articles have been found which, while remaining substantially the same, have been subject to few fluctuations in prices. Upon inquiry it has been found that the sale of these articles has been a restricted one, that they did not enter into competition with the other grades of manufacture of the same class. Their price is therefore due to special conditions. It is needless to say that such a price, although preserving the identity of the unit, is not a market price in the sense in which that term is generally used. The great bulk of articles selected, however, are governed in prices by the usual conditions of trade, and it is believed that they will fairly represent the course of manufactured articles. In obtaining wholesale prices in this fashion of certain specific manufactured goods, the identity of the unit is admirably preserved.

In comparing prices of different periods it is found necessary to use information coming from different sources, and in such cases the greatest care must be exercised to ascertain whether the methods of figuring the prices have been identical. None of these methods are perfect, and, while one may

sin in the direction of too high a price, another may sin in the opposite direction. A series of prices for different years, formed partly according to one method and partly according to another, would, therefore, greatly impair the accuracy of the comparison. If, however, we desire to compare two series of prices, it is of comparatively little consequence whether the prices in the one case were obtained in the same fashion as in the other. In such a case it would not do to establish a ratio between the prices of the two series in each year, since such a ratio would probably be incorrect, but we can compare the prices of the two commodities as series. We do not compare their absolute amounts, but their relative variations. The simplest and most effective method of so doing is to take the price of some one year, as 100, and express the other prices of the same series in percentages of this price. The two series reduced to this common form are then absolutely comparable so far as their fluctuations are concerned.

The reason for the rule just stated has been clearly demonstrated in a recent article by Dr. Venn, on the *Nature and Uses of Averages*, in the Journal of the Statistical Society for September, 1891. He there shows that, while for some purposes particular classes of averages must be used, for the mere purpose of comparing groups of phenomena among themselves any form of average which approximately measures the facts will suffice. It must, therefore, be evident that, if from such averages we form a series, we can compare this series with another formed from other averages, even though the latter belong to a different class.

In comparing different groups of prices the analogy required by statistical theory is of a somewhat broader scope. In this case we consciously compare wholesale with retail prices, or farmers' prices with market prices, and the only analogy is in the fact that they are all prices of one class or another.

Comparison between wholesale and retail prices can only be made locally, that is, there must be a relation between the

wholesale and the retail prices. We would not compare the retail prices in Philadelphia with the wholesale prices in Chicago, but we might compare retail prices in Joliet with wholesale prices in Chicago, for it may be assumed that the retailer in Joliet either draws his supplies from Chicago, or that the wholesale prices of the latter place govern the wholesale prices in Joliet. The attempt has been made frequently of recent years to ascertain the amount charged by the retailer in excess of the wholesale price. Not only has this been attempted in cases where the retailer sells directly the goods which he has purchased, but in some few cases where a manufacturing process has taken place, as, for instance, comparing the price of bread with that of flour. The greatest difficulty in such comparison is the preservation of the identity of the unit. Take the simple case of coffee. The retail prices, while nominally for the same article as wholesale prices, differ so widely that the suspicion is awakened that a difference in quality must exist.* It need not be said that this difficulty will be overcome if we could ascertain from the retailer the price which he has paid for the articles. But few merchants are so imbued with the statistical spirit that they are willing to disclose their private affairs to this extent. While we can secure from the retailer the price which he charges his customers, we are obliged to secure the wholesale prices from different sources. Again, in retail trade the possibility of making profit on various kinds of adulteration is so great that it impairs the value of such comparison. The deterioration of goods which have been long in stock is another disturbing element.

Another difficulty in such comparisons arises from the fact that, while wholesale prices are apt to be averages, retail prices are usually collected in the form of concrete actual prices. We do not know whether the average price corresponds in any way with the price paid by the particular retailer, and our investigation must be very broad, even if this is true in the main.

*See Bayerdörffer's investigation, also the French investigation already noted.

If we desire to compare the retail prices of different periods with wholesale prices at the same periods, all the difficulties which we have remarked in comparing different localities apply with still greater force. The information which we can secure is not very accurate. The conditions which prevailed in the retail trade twenty or thirty years ago as compared with those of today are not sufficiently known to enable us to secure accurate data for comparison. If it is difficult to ascertain the relation of the wholesale to the retail prices today, it must be doubly so if our comparison is to be made in a more remote period.

On the other hand, it is not difficult to make a comparison of the course of prices. Just as we can compare the course of prices of two different commodities by reducing them to a series, so we can compare the course of retail prices with the course of wholesale prices of the same commodity by reducing each to a series. In this case, while we may not be sure that the articles compared are exactly the same, we can safely assume that each is representative, one showing the course of wholesale prices, and another the course of retail prices, and these two series may be compared. We can thus ascertain with considerable accuracy whether like tendencies have prevailed in the two branches of commerce, or if there has been a divergence, what has been its character.*

In conclusion, we may briefly restate the limitations upon statistical comparisons which result not only from the difficulty of observing the theoretical rules, but also from the character of the data at our command. For the reasons which we have given, comparisons of prices between different localities can only be made with the greatest caution. The possibility of error is very great. On the other hand, comparisons for different periods for the same article are comparatively easily made, and are fairly accurate. The conditions are such that we must accept local comparisons between different classes of prices only with extreme diffidence, while, on the

* See the tables in Bayerdörffer's study.

other hand, comparisons of this nature between different periods are comparatively accurate. It will be seen that the reduction of price series to common terms is of invaluable aid in all these comparisons.

This examination of the actual condition of price statistics has been carried on in the light of statistical theory as developed by Prof. Meitzen. Such investigations are the real test of statistical theory. If the latter makes clearer the difficulties which practical statisticians have encountered, and which they have endeavored to surmount, we can hope that the application of statistical theory to the various fields of practice will not only explain present difficulties, but help us to avoid obstacles in the future.